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Algal Structural Complexity Effect on Diversity and Abundance of Some Ostracod Species from Red Sea Coast, Egypt

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Abstract Four species of macroalgae (*Sargassum obtusifolium*, *Sargassum polyphyllum*, *Chnoospora minima*, *Nemacystus decipiens*) were collected monthly to study the changes in ostracod species abundance, richness and diversity between them during 12 months. Also, determine effect of algal structural complexity on ostracod abundance and diversity. Structural complexity was estimated by counting the number of branches cm^{-1} for each one of the four studied algae. There were significant differences in complexity between the 4 algal species. *Sargassum obtusifolium* had significantly more branches cm^{-1} than the remaining 3 algal species, and *Sargassum polyphyllum* had significantly more branches than *Chnoospora minima*, and *Nemacystus decipiens*. There were differences in abundance and diversity of ostracod assemblages between the four algal species. Where, *Sargassum obtusifolium* carried a higher abundance, species richness and diversity of ostracods during study period than that of the residual three algae. The ostracod samples of four studied algae nearly formed separate clusters, reflecting the difference between these algae throughout the year. Sixteen species of ostracod occurred on the algae, six only occurred at sufficient densities for determination of their life-cycles. *Cylindroleberis* sp., *Ghardaglaia triebeli* and *Mosella striata* occurred at high densities and had two generations per year. The other three abundant ostracod species; *Loxoconcha ornatovalve*, *Paradoxostoma altecaudatum* and *Xestoleberis ghardaqe* found at low densities and had one generation per year.

Keywords Marine Ostracods, Structure Complexity, Population Dynamics, Reproduction and Ontogeny, Red Sea

1. Introduction

Ostracods are small bivalved Crustacea, their carapace envelope the whole body and limbs. They live in all aquatic environments and grow by molting their shells eight times to reach the adult stage during lifecycle. Ostracoda have a wide range of diets as carnivores, scavengers, filter feeders and herbivores, while they nearly form more than 98% of the phytal meifauna (Hull, 1997).

Many of ecological studies have documented that habitats have an effect on species richness and diversity[1, 2]. On the other hand, habitat complexity is associated with texture, size and shape of algal species[1], so that the higher densities of animals correlate with more algal structural complexity[3].

Other studies reported that an increasing of habitat complexity may be increase the diversity and abundance of organisms[4], as a result of increased protection from predation, wave action and dissection[5-7]. Above all, marine algae provide a suitable habitat for many of animal species especially invertebrates which use macroalgae as a shelter from physical stress, predators[8] and depend on them as a source of food[9, 10].

The previous studies on phytal ostracods have been concentrated on the description of the assemblages in space and have not considered the seasonal dynamics of the assemblages over time or between different algal species [11-13], for the reason of collection and identification problems of small species. However, some authors studied the dynamics of ostracod assemblages[14-17].

The current study aims to determine the source of the significance between mean branches of four species of Red Sea algae, to estimate monthly differences in ostracod densities on studied algae and examine the lifecycle of some ostracod species so as to determine if diversity and abundance of ostracod vary with the structure complexity of algae.

2. Material and Methods

Samples of four species of macroalgae (*Sargassum obtusifolium*, *Sargassum polyphyllum*, *Chnoospora minima*, *Nemacystus decipiens*) were randomly collected each month

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from an exposed sand rocky shore rich with different types of macroalgae situated at 35km South of Safaga city of Egypt (Fig. 1), during the period from June 2010 and May 2011. The four studied macroalgal species were present in the studied area all over the year and they have difference in their frond structures. A sub-sample of the four species of algae was collected to measure their frond length and number of branches and to estimate the degree of branching per unit length for each one of them.

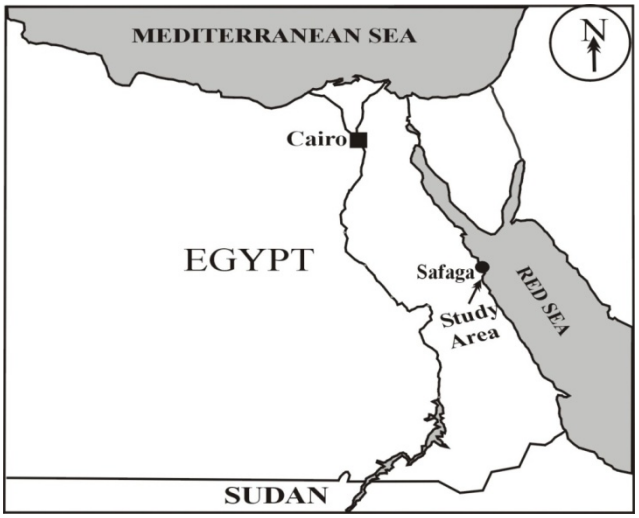


Figure 1. Location map of the study area

The samples were preserved in 4% formaldehyde with some of the seawater. In laboratory, the algae were washing with water jet to separate ostracod species through 40µm sieve and then the algae were checked to ensure that all ostracods have been removed. After that the algae were dried and weighted. Number of ostracods calculated per 20 g dry weight for each of the four species of algae.

The ostracods were picked from the sieve and stored in 70 % alcohol until begin analysis. All the individual ostracods collected from each sample were identified and their carapaces length was measured using an eye-piece graticule, in order to identify the developmental instars. Ostracod species were dissected for accurate identification and was studied by using both a high-power compound microscope and binocular microscope. As well as the taxonomy based on that of[18-22].

3. Statistical Analysis for Data

Statistical analyses were performed by using 1-way and 2-factor ANOVA tests. They were of fixed, balanced design; therefore Tukey's tests were performed to determine the source of the significance between means[23]. One way ANOVA was used to determine significant differences in ostracod densities either between algal species or over the sampling period. Two-factor ANOVAs were used to examine the significance of the effect of algal species and month over the sampling period. Six ostracod species occurred in sufficiently high densities throughout the year to enable their lifecycles to be determined and changes in density to be statistically tested using ANOVA.

Shannon Wiener diversity (H'), species richness (S) and Evenness (E) were calculated on ostracod samples for each species of algae within each month. ANOVA was used to test for significant differences in diversity between the algal species and over the sampling period within an algal species. A dendrogram was produced using SPSS version 16.0.

4. Results

4.1. Description of Algal Species

By comparing the number of branches cm^{-1} for the four species of algae (Table 1) there was significant difference in number of branches between the four studied species of algae (ANOVA F= 582.33, $P < 0.000$; Tukey $p = 0.05$), where the highest degree of branches was found in *Sargassum obtusifolium,* which had higher number of branches than the three other species. *Sargassum polyphyllum* had higher number of branches than *Chnoospora minima* and *Nemacystus decipiens* and there was significant difference in number of branches between *C. minima* and *N. decipiens*.

Table 1. The mean number of branches cm^{-1} for the four algal studied species

Species	Mean branches cm^{-1}	SD
Sargassum obtusifolium	24.7	1.4
Sargassum polyphyllum	18.8	1.3
Chnoospora minima	9.1	0.73
Nemacystus decipiens	5.3	0.34

4.2. Density of Ostracod Species

Sixteen ostracod species from two orders and six families were identified from the samples of algae which collected during the study period (Appendix 1). Fig.2 shows the mean ostracod density on the 4 algal species during study period. There were significant differences in ostracod density both between the four species of algae each month (2-way ANOVA, $p < 0.013$ in all cases). In general, *S. obtusifolium* (mean ostracod density= (468.5 ± 134.086 SD) carried higher ostracod densities than *C. minima* (mean =174.312 ± 83.745), *N. decipiens* (mean =143.812 ± 62.778) and *S. polyphyllum* (mean = 250.75 ± 125.0166), whereas *S. polyphyllum* carried higher densities than *C. minima* and *N.* decipiens (ANOVA F= 41.11, $p < 0.000$; Tukey $p = 0.05$).

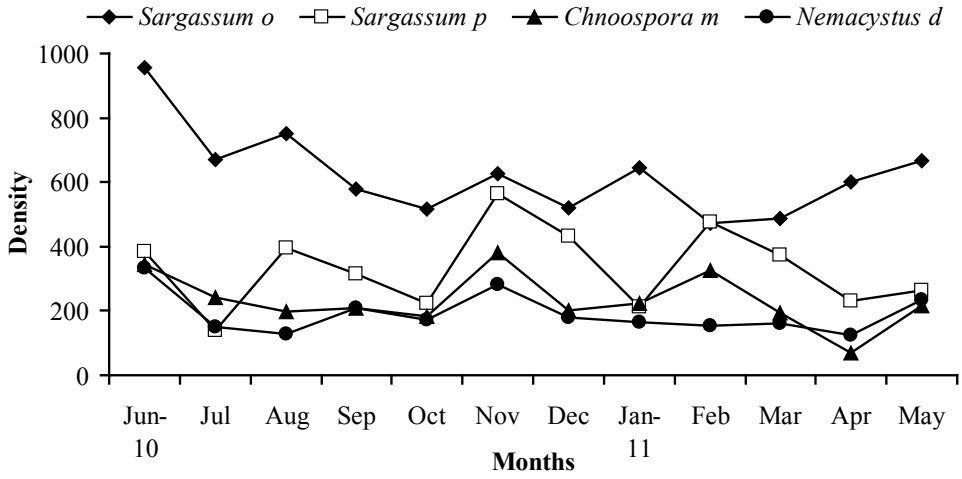


Figure 2. Changes in ostracod density on the four studied algal species during 12 months

On *S. obtusifolium*, there was no significant difference in ostracod density, the highest and lowest occurred in June and February 2010, respectively and the density found in August 2010 was higher than that found in July, November 2010 and May 2011 (ANOVA F= 0.26 p < 0.992; Tukey p = 0.05). Also, there was no significant difference in ostracod density on *S. polyphyllum* where, the highest density found in November 2010 followed by February 2011 and December 2010, respectively (ANOVA F= 0.93 p < 0.513; Tukey p = 0.05). In addition, on *C. minima* the ostracod density was not significantly higher during February 2011 than throughout the rest of the year except for November and June 2010 (ANOVA F= 0.72, p < 0.722; Tukey p = 0.05). *N. decipiens* had no significant difference in ostracod density where the highest density occurred in June 2010 (ANOVA F= 0.44, p = 0.935; Tukey p = 0.05).

4.3. Life Cycle and Population Density of Ostracod

Sixteen ostracod species recovered from the studied algal species, six species of them occurred in abundant numbers to study changes in their life cycles and population density (*Cylindroleberis* sp., *Ghardaglaia triebeli*, *Mosella striata*, *Loxoconcha ornatovalve*, *Paradoxostoma altecaudatum* and *Xestoleberis ghardaqe*). The remaining species (*Hemicytherura videns*, *Semicytherura rectangularis*, *Semicytherura affinis*, *Neonesidea schulzi*, *Neonesidea conulifera*, *Paranesidea fracticoralicola*, *Loxoconcha ghardaqensis*, *Loxoconcha gisella*, *Paradoxostoma subtile* and *Xestoleberis simplex*) found in small number of densities so that they are excluded from this analysis. Six ostracod species showed significant changes in density between the algal species and month (2-way ANOVA p < 0.000 in all cases). In general, *S. obtusifolium* carried the highest population densities of *Cylindroleberis* sp., *Ghardaglaia triebeli*, *Mosella striata*, *Semicytherura affinis Neonesidea conulifera*, *Paranesidea fracticoralicola*, *Loxoconcha ghardaqensis* and *Xestoleberis simplex* comparing to the remaining three algae. *Hemicytherura videns*, *Semicytherura rectangularis* and *Loxoconcha ornatovalve* occurred in significantly higher densities on *Sargassum polyphyllum*, while *Chnoospora minima* carried the highest population densities of *Paradoxostoma altecaudatum* and *Paradoxo stoma subtile*.

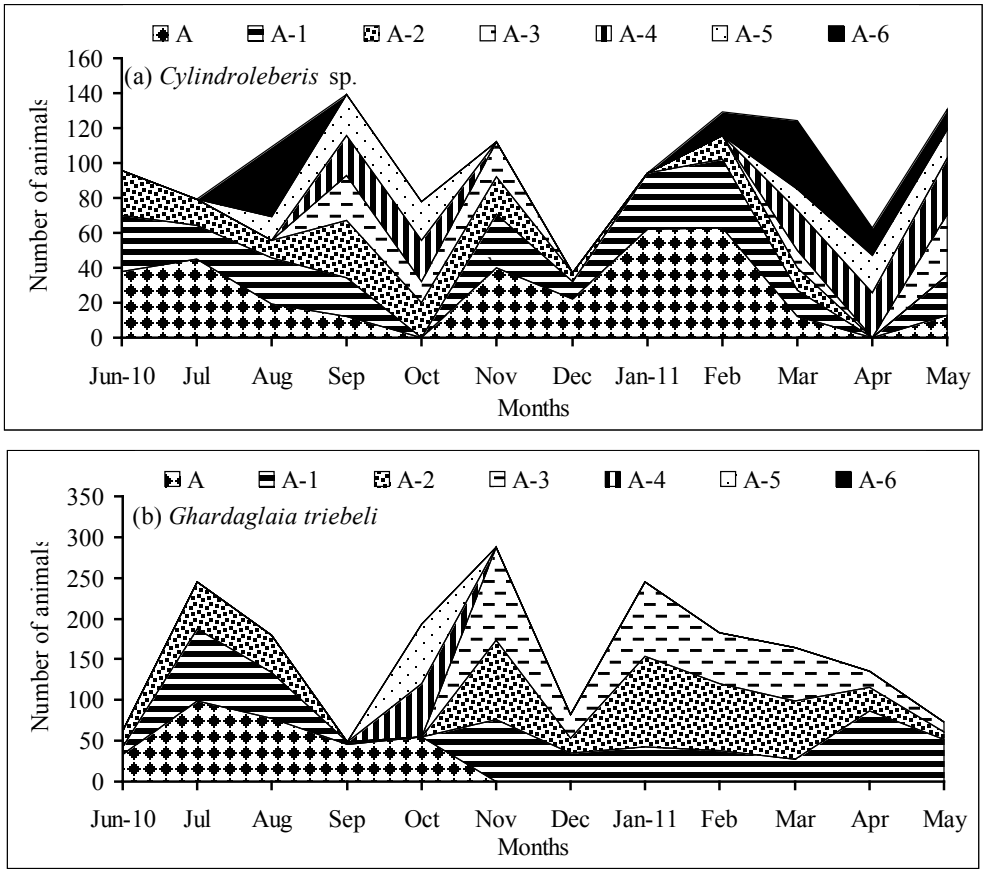
Fig. 3a demonstrates the life-cycle of *Cylindroleberis* sp. where reproduction occurred in last spring and last winter due to the appearance of A-5 and A-6 instar stages in July 2010 and January 2011. These instars matured during summer and spring months and the population appeared low of adult densities. There was significant difference in the population densities of *Cylindroleberis* sp. where higher densities occurred in September, May and February than that in all study year months (ANOVA F= 3.00, p < 0.011; Tukey p = 0.05). Fig. 3b illustrates the life-cycle of *Ghardaglaia triebeli* where adults appear in the population in summer and spring as soon as reproduction took place resulting appearance of A-4 and A-5 instar stages in September-October 2010 which moulting to adults in the next spring. *Ghardaglaia triebeli* had a significant difference in population density all over the year (ANOVA F= 4.85, p < 0.000; Tukey p = 0.05) where higher densities occurred in November, July and January, respectively. In the life-cycle of *Mosella striata* (Fig. 3c) adults occurred in the population from June to September and from November to January according to that A-6 and A-5 appeared in the population from the middle of summer to the end of winter. There was no significant difference in population density of *Mosella striata* (ANOVA F= 1.18, p < 0.326; Tukey p = 0.05) where the highest density found in June 2010 and the lowest one occurred in February 2011. Fig. 3d showing the life-cycle of *Loxoconcha ornatovalve* which include appearance of A and A-1 in summer where reproduction took place due to appearance of A-4, A-5 and A-6 in August- October. These juvenile moulting to adult forms in the following summer. *L. ornatovalve* had significant difference in population density (ANOVA F= 2.82, p < 0.015; Tukey p = 0.05) with higher density in September 2010 and May 2011 than the remaining months of year. A-1 stage of *Paradoxostoma altecaudatum* (Fig. 3e) moulted to adults in summer and A-4 and A-5

appeared in population from September to January which moulted to higher stages until became adults in the end of spring. There was no significant difference in *P. altecaudatum* population density (ANOVA F= 0.74, p < 0.617; Tukey p = 0.05) where higher population density occurred in November than that of July 2010 and February 2011. In life-cycle of *Xestoleberis ghardaqe* (Fig. 3f) A-6 and A-5 appeared in summer and then moulted to higher stages in the following months till became adults in spring. *X. ghardaqe* had no significant population density (ANOVA F= 1.63, p < 0.149; Tukey p = 0.05) where higher densities occurred in October 2010 and May 2011than those found in the residual months throughout year.

4.4. The Variation in Ostracod Diversity, Richness and Evenness

Fig. 4 demonstrates the diversity (Fig. 4a), richness (Fig. 4b) and evenness (Fig. 4c) of the ostracod assemblages on the four species of algae throughout the year. There was a significant difference in Shannon Wiener H' both between algal species and months within each algal species (2-way ANOVA p < 0.038 in all cases). As soon as *Nemacystus decipiens* had lower diversity than *Sargassum obtusifolium, Sargassum polyphyllum* and *Chnoospora minima* (Fig. 4a: ANOVA F = 6.31, p = 0.001; Tukey p = 0.05), however there was no significant difference in ostracod diversity between the three other algal species (Fig. 4a: ANOVA F = 2.41, p = 0.134; Tukey p = 0.05).

Sargassum obtusifolium showed no monthly significant differences in diversity (ANOVA F= 0.16, p = 0.999), where the lowest and highest values of diversity found in February 2011 and June 2010, respectively. As well as the residual three species of algae demonstrated no significant differences in ostracod diversity monthly. For *Sargassum polyphyllum,* the highest diversity value occurred in April 2011, while, November 2010 sample had a lower diversity than July and September 2010, and the March 2011 sample had a higher diversity than October 2010, January and February 2011 (ANOVA F = 0.19, p = 0.998; Tukey p = 0.05). On *Chnoospora minima* the April and June 2010 samples had the lowest and highest diversity values throughout the year samples (ANOVA F=0.17, p = 0.999; Tukey p =0.05). For *Nemacystus decipiens,* the highest and lowest of diversity values occurred in June and August 2010, respectively, In addition February and March 2011 samples had a higher diversity than September-November 2010 and April-May 2011 samples (ANOVA F=0.68, p = 0.753; Tukey p =0.05). Species richness on the four studied species of algae are distinguishing as follow (Fig. 3b), the median number of species on *Sargapssum obtusifolium* was 12 higher than that on *Sargassum polyphyllum* (median number= 11), on *Chnoospora minima* (median number= 9.5) and on *Nemacystus decipiens* (median number= 9).



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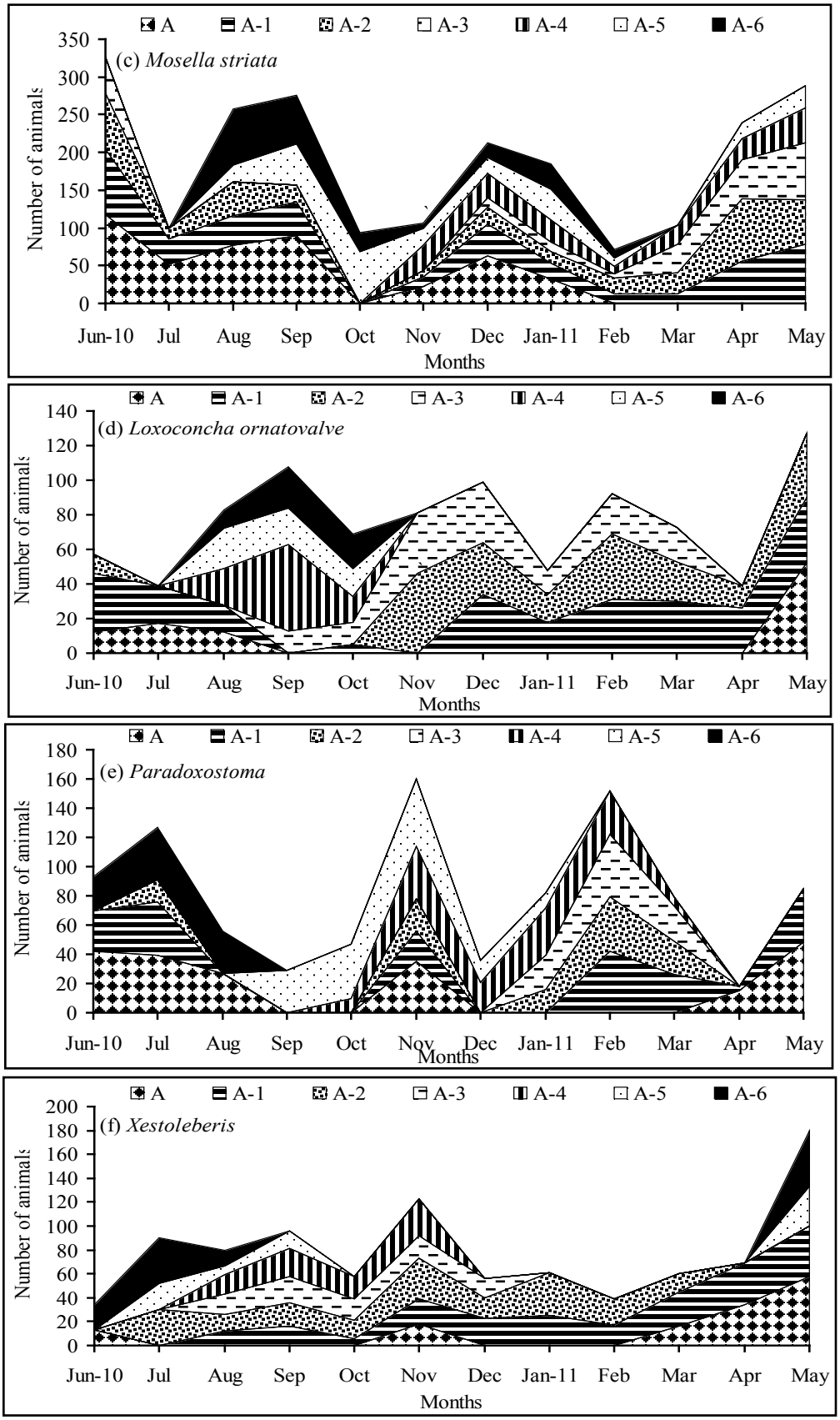

Figure 3. Life-cycle of the six abundant ostracod species revealing changes in population density and appearance of different instars within each population. The instars are mareked as follow: A= adult, A-1= 8th instar, A-2= 7th instar, A-3= 6th instar, A-4= 5th instar, A-5= 4th instar, A-6 = 6th instar

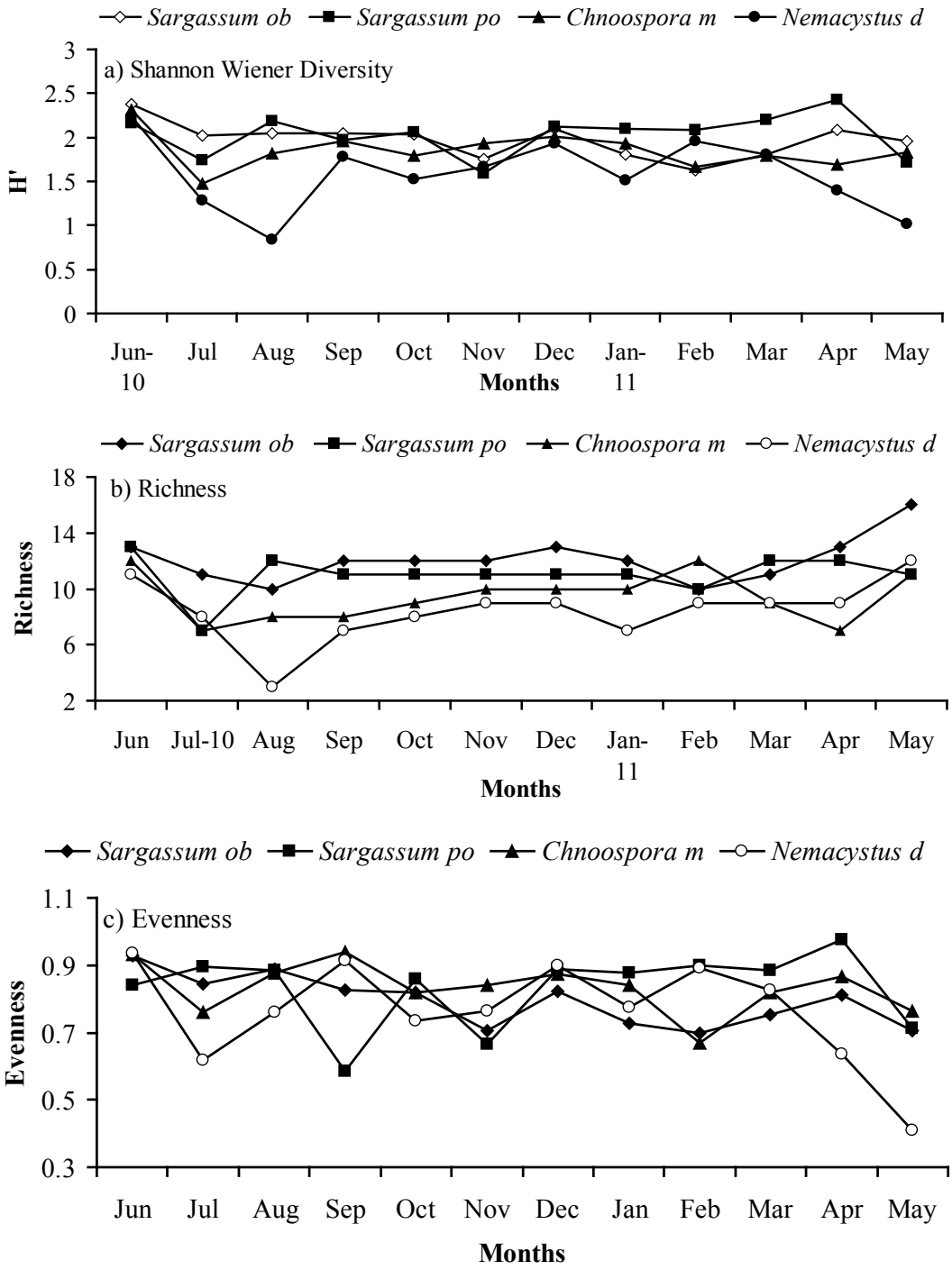

Figure 4. Monthly changes in ostracod Shannon Wiener diversity, species Richness and Evenness on four studied species of algae during 12 months

Evenness (Fig. 4b) in *Sargapssum obtusifolium* was high in summer and autumn and low in winter, while evenness was high throughout the year of study period except in September, November and May in *Sargassum polyphyllum* and in July and Feruary in *Chnoospora minima*, respectively. Additionally, evenness in *Nematocystus decipiens* was low during the year of study period except in June, September, December and February.

The dendrogram from cluster analysis (Fig. 5) composed of four clusters. Cluster A composed wholly of the 12 *Nematocystus decipiens* samples and 3 *Chnoospora minima* samples. Cluster B consisted of eight *Chnoospora minima* samples. In cluster C there are eleven samples, ten samples from *Sargassum polyphyllum* and one from *Chnoospora minima*. Whereas, cluster D composed totally of fourteen samples, twelve from *Sargapssum obtusifolium* and two from *Sargassum polyphyllum*. Accordingly, multivariate analysis revealed clear differences in ostracod densities both between the four species of algae each month.

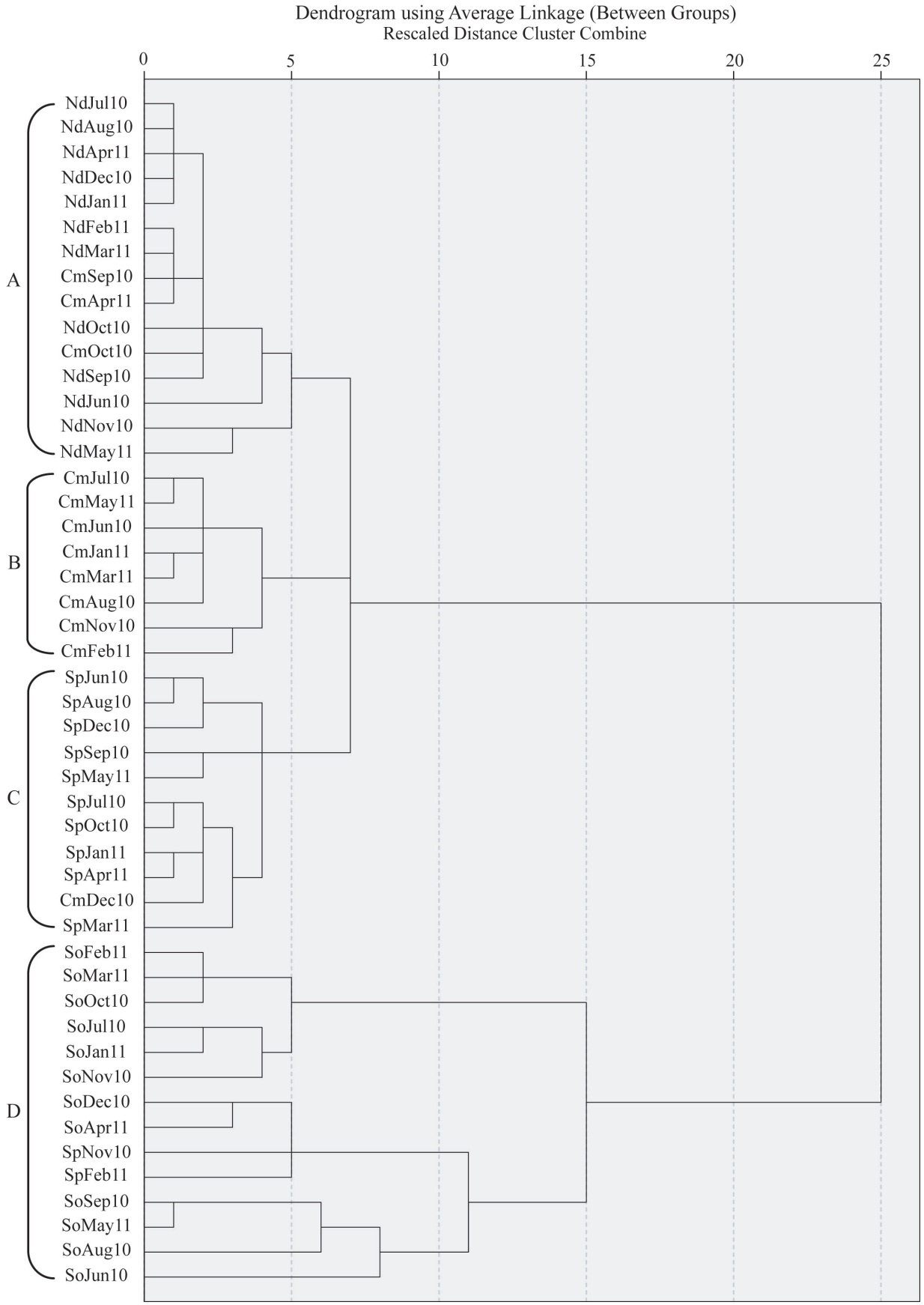

Figure 5. Dendrogram cluster analysis for monthly samples of four species of algea during 12 months (Key: So=*Sargassum obtusifolium*, Sp=*Sargassum polyphyllum*, Cm=*Chnoospora minima*, Nd-*Nemacystus decipiens*)

5. Discussion

The density of phytal ostracods changes according to the degree of algal structural complexity. The results of the current study demonstrate that *S. obtusifolium* had the most complex frond structure and carried higher densities of ostracods than the residual 3 algal species. Similar data recorded by[17] on 18 ostracod species associated with four species of algae. Furthermore, high complexity habitats support a larger diversity, richness of species and a greater abundance of individuals than medium or low diversity habitats. Similar suggestion recorded by[3] and[11].

During the current study, there was no significant difference in ostracod density on the four studied species of algae. Also,[24] reported similar data, however[17] noted that there are significant difference in ostracod density on *Ceramium*, *Chondrus* and *Corallina* and there is no significant difference in ostracod density on *Cladophora*.

It is likely to note that, life cycles of ostracod species in the Red Sea waters have been poorly investigated so the current study revealed that, *Cylindroleberis* sp., *G. triebeli* and *M. striata* have two generations per year. While *L. ornatovalve*, *P. altecaudatum* and *X. ghardaqe* have one generation per year.[25, 26] described one generation annually for *Hirschmannia viridis* and *Cyprideis torosa*, respectively. However,[27] found one to three generations per year of the seven species of ostracods he investigated.[16] found 4 to 5 generations per year of some ostracod species in brackish water.

In *Cylindroleberis* sp. reproduction occurred in last spring and last winter, while *Ghardaglaia triebeli* matured in summer and spring and in *Mosella* sp. reproduction occurred during summer and last winter.

The higher densities of *Cylindroleberis* sp. were found in autumn and summer, while in *Ghardaglaia triebeli* occurred in winter and summer. Additionally, higher density in *Mosella* sp. occurred in summer. [11, 17] reported that higher density of *C. lutea* occurred in winter.[11] noted that the low densities of *H. viridis* observed during the winter months due to seasonal migration to sublittoral areas.

In our study, the other three studied species: *Loxoconcha ornatovalve*, which demonstrated positive difference in population density and its reproduction, took place in August-October due to appearance of A-4, A-5 and A-6. *Paradoxostoma altecaudatum* and *Xestoleberis ghardaqe* they demonstrated no significant difference in their population density. *P. altecaudatum* moulted to adults in summer and A-4 and A-5 appeared in population in autumn, while A-6 and A-5 of *X. ghardaqe* appeared in summer.[17] noted that *X. aurantia* demonstrated positive covariation in population density with high densities during August-Septe mber and reported that the genus *Paradoxostoma* occurred at low densities during spring and early summer.

A total of sixteen ostracod species were recovered from the studied algal species, six species of them occurred in abundant numbers to study changes in their life cycles compared to ten species at low densities.[17] studied 18 species of ostracod were found on the algae, but only 8 occurred at densities sufficient for determination of their life-cycles compared with ten species at low densities,[11] found 7 species at low densities on *Chondrus,* compared with 14 species in high densities during spring and summer on *Cladophora*

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Appendix : Monthly Ostracod Numbers on Four Studied Species of Algae during One Year

Species		Jun-10	Jul	Aug	Sep	Oct	Nov	Dec	Jan-11	Feb	Mar	Apr	May	Total
Sargassum obtusifolium														
I- Order: Myodocopida														
1-Family: Cylindroleberdidae														
Cylindroleberis sp.		96	79	109	132	78	112	37	94	129	124	63	131	**1184**
II- Order: Podocopida														
1- Family: Cyprididae														
Ghardaglaia triebeli	Hartmann, 1964	67	245	179	49	194	287	82	245	183	164	136	73	**1904**
2– Family: Cytheridae														
Mosella striata	Hartmann, 1964	326	148	257	276	94	107	213	185	72	103	239	289	**2309**
Hemicythenura videns	Hartmann, 1964	58	13	0	0	18	33	0	0	0	17	0	6	**145**
Semicytherura rectangularis	Bonaduce, Masoli & Pugliese, 1980	39	27	0	16	3	9	14	0	3	22	33	7	**173**
Semicytherura affinis	Bonaduce, Masoli & Pugliese, 1980	65	33	16	6	27	0	0	6	0	9	31	16	**209**
3-Family: Bairdiidae														
Neonesidea schulzi	(Hartmann, 1964)	48	0	34	18	0	0	15	20	0	5	9	12	**161**
Neonesidea conulifera	Hartmann, 1964	27	0	26	20	0	13	26	0	28	5	9	17	**171**
Paranesidea fracticoralicola	Maddocks, 1969	67	39	0	0	0	6	17	10	4	0	0	27	**170**
4- Family: Loxoconchidae														
Loxoconcha ghardaqensis	Hartmann, 1964	0	25	45	0	5	8	29	17	0	5	9	18	**161**
Loxoconcha ornatovalve	Hartmann, 1964	33	0	0	8	0	9	45	23	0	16	16	14	**164**
Loxoconcha gisellae	Bonaduce, Masoli & Pugliese, 1980	40	19	22	19	14	12	4	7	0	19	18	5	**179**
5-Family: Paradoxostomatidae														
Paradoxostoma altecaudatum	Bonaduce, Masoli & Pugliese, 1980	0	0	0	0	7	16	0	5	8	0	0	18	**54**
Paradoxostoma subtile	Bonaduce, Masoli & Pugliese, 1980	35	24	26	7	34	0	9	15	7	0	13	8	**178**
6- Family: Xestoleberdidae														
Xestoleberis ghardaqe	Hartmann, 1964	55	0	0	15	26	16	24	0	8	0	20	5	**169**
Xestoleberis simplex	Hartmann, 1964	0	20	38	11	17	0	5	19	30	0	3	22	**165**
Total		**956**	**672**	**752**	**577**	**517**	**628**	**520**	**646**	**472**	**489**	**599**	**668**	

Continued:

Sargassum polyphyllum														
I- Order: Myodocopida														
1-Family: Cylindroleberdidae														
Cylindroleberis sp.	Kornicker, 1992	15	27	0	7	0	8	9	18	23	6	9	0	**122**
II- Order: Podocopida														
1- Family: Cyprididae														
Ghardaglaia triebeli	Hartmann, 1964	41	0	24	38	0	190	57	29	106	0	36	48	**569**
2– Family: Cytheridae														
Mosella striata	Hartmann, 1964	114	0	90	58	29	205	83	49	142	53	29	0	**852**
Hemicytherura videns	Hartmann, 1964	4	6	19	30	0	0	31	17	0	52	35	7	**201**
Semicytherura rectangularis	Bonaduce, Masoli & Pugliese, 1980	0	0	0	8	16	3	27	0	59	46	8	19	**186**
Semicytherura affinis	Bonaduce, Masoli & Pugliese, 1980	6	25	11	0	9	28	0	6	16	0	8	4	**113**
3-Family: Bairdiidae														
Neonesidea schulzi	(Hartmann, 1964)	0	0	0	24	9	16	0	4	6	17	11	8	**95**
Neonesidea conulifera	Hartmann, 1964	14	0	32	11	7	9	12	0	22	6	3	0	**116**
Paranesidea fracticoralicola	Maddocks, 1969	7	0	12	17	3	0	22	5	0	16	4	8	**94**
4- Family: Loxoconchidae														
Loxoconcha ghardaqensis	Hartmann, 1964	35	6	8	0	16	9	0	0	6	8	0	7	**95**
Loxoconcha ornatovalve	Hartmann, 1964	57	39	83	108	69	81	99	48	92	73	39	127	**915**
Loxoconcha gisellae	Bonaduce, Masoli & Pugliese, 1980	45	29	58	0	37	0	62	0	0	34	41	8	**314**
5-Family: Paradoxostomatidae														
Paradoxostoma altecaudatum	Bonaduce, Masoli & Pugliese, 1980	25	0	17	0	5	9	20	13	0	55	0	18	**162**
Paradoxostoma subtile	Bonaduce, Masoli & Pugliese, 1980	16	8	27	4	22	0	0	17	4	8	0	9	**115**
6- Family: Xestoleberdidae														
Xestoleberis ghardaqe	Hartmann, 1964	0	0	0	0	0	6	0	0	0	0	9	0	**15**
Xestoleberis simplex	Hartmann, 1964	7	0	15	9	0	0	11	6	0	0	0	0	**48**
Total		**386**	**140**	**396**	**314**	**222**	**564**	**433**	**212**	**476**	**374**	**232**	**263**	

Continued:

Chnoospora minima														
I- Order: Myodocopida														
1-Family: Cylindroleberdidae														
Cylindroleberis sp.	Kornicker, 1992	13	14	0	0	7	9	0	0	26	9	0	4	**82**
II- Order: Podocopida														
1- Family: Cyprididae														
Ghardaglaia triebeli	Hartmann, 1964	29	0	8	17	0	0	42	39	0	41	4	3	**183**
2– Family: Cytheridae														
Mosella striata	Hartmann, 1964	68	39	50	0	0	63	41	17	0	15	0	34	**327**
Hemicytherura videns	Hartmann, 1964	0	0	0	0	0	18	34	8	9	0	0	0	**69**
Semicytherura rectangularis	Bonaduce, Masoli & Pugliese, 1980	31	14	0	0	7	29	0	0	26	9	0	4	**120**
Semicytherura affinis	Bonaduce, Masoli & Pugliese, 1980	0	0	8	19	2	18	0	15	34	7	2	0	**105**
3-Family: Bairdiidae														
Neonesidea schulzi	(Hartmann, 1964)	0	0	0	0	0	0	9	23	0	0	0	5	**37**
Neonesidea conulifera	Hartmann, 1964	5	0	9	16	36	0	0	18	22	0	9	23	**138**
Paranesidea fracticoralicola	Maddocks, 1969	0	9	32	18	0	0	0	0	24	14	0	5	**102**
4- Family: Loxoconchidae														
Loxoconcha ghardaqensis	Hartmann, 1964	31	0	0	0	0	0	15	7	3	0	0	0	**56**
Loxoconcha ornatovalve	Hartmann, 1964	7	0	0	16	4	7	2	0	0	0	4	19	**59**
Loxoconcha gisellae	Bonaduce, Masoli & Pugliese, 1980	10	0	0	0	0	0	8	2	6	11	10	0	**47**
5-Family: Paradoxostomatidae														
Paradoxostoma altecaudatum	Bonaduce, Masoli & Pugliese, 1980	93	127	56	29	47	160	36	82	152	79	18	85	**964**
Paradoxostoma subtile	Bonaduce, Masoli & Pugliese, 1980	45	24	9	0	36	27	10	0	5	0	0	31	**187**
6- Family: Xestoleberdidae														
Xestoleberis ghardaqe	Hartmann, 1964	10	0	25	56	39	41	5	0	14	0	22	3	**215**
Xestoleberis simplex	Hartmann, 1964	2	14	0	38	5	9	0	14	6	10	0	0	**98**
Total		**344**	**241**	**197**	**209**	**183**	**381**	**202**	**225**	**327**	**195**	**69**	**216**	

Continued:

Nemacystus decipiens														
I- Order: Myodocopida														
1-Family: Cylindroleberdidae														
Cylindroleberis sp.	Kornicker, 1992	0	5	0	0	4	12	20	0	0	23	0	0	**64**
II- Order: Podocopida														
1- Family: Cyprididae														
Ghardaglaia triebeli	Hartmann, 1964	34	0	9	26	0	0	0	0	16	23	0	4	**112**
2– Family: Cytheridae														
Mosella striata	Hartmann, 1964	48	17	0	0	0	9	3	11	0	0	6	2	**96**
Hemicytherura videns	Hartmann, 1964	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Semicytherura rectangularis	Bonaduce, Masoli & Pugliese, 1980	45	2	0	7	12	0	0	0	23	7	2	1	**99**
Semicytherura affinis	Bonaduce, Masoli & Pugliese, 1980	0	0	0	0	48	0	0	4	9	0	0	7	**68**
3-Family: Bairdiidae														
Neonesidea schulzi	(Hartmann, 1964)	57	1	0	7	0	45	15	0	6	12	4	2	**149**
Neonesidea conulifera	Hartmann, 1964	9	0	0	27	0	11	23	0	0	0	6	3	**79**
Paranesidea fracticoralicola	Maddocks, 1969	4	0	0		28	0	0	0	7	9	0	3	**51**
4- Family: Loxoconchidae														
Loxoconcha ghardaqensis	Hartmann, 1964	24	0	0	0	8	0	28	51	0	0	4	7	**122**
Loxoconcha ornatovalve	Hartmann, 1964	27	0	0	0	0	0	7	4	32	1	9	0	**80**
Loxoconcha gisellae	Bonaduce, Masoli & Pugliese, 1980	0	0	0	0	6	4	24	7	0	0	0	5	**46**
5-Family: Paradoxostomatidae														
Paradoxostoma altecaudatum	Bonaduce, Masoli & Pugliese, 1980	0	26	39	0	0	41	0	27	0	4	7	2	**146**
Paradoxostoma subtile	Bonaduce, Masoli & Pugliese, 1980	36	2	0	40	9	4	5	0	7	0	0	19	**122**
6- Family: Xestoleberdidae														
Xestoleberis ghardaqe	Hartmann, 1964	34	90	82	96	58	123	56	61	39	60	79	180	**958**
Xestoleberis simplex	Hartmann, 1964	15	9	0	6	0	32	0	0	16	23	8	0	**109**
Total		**333**	**152**	**130**	**209**	**173**	**281**	**181**	**165**	**155**	**162**	**125**	**235**	

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